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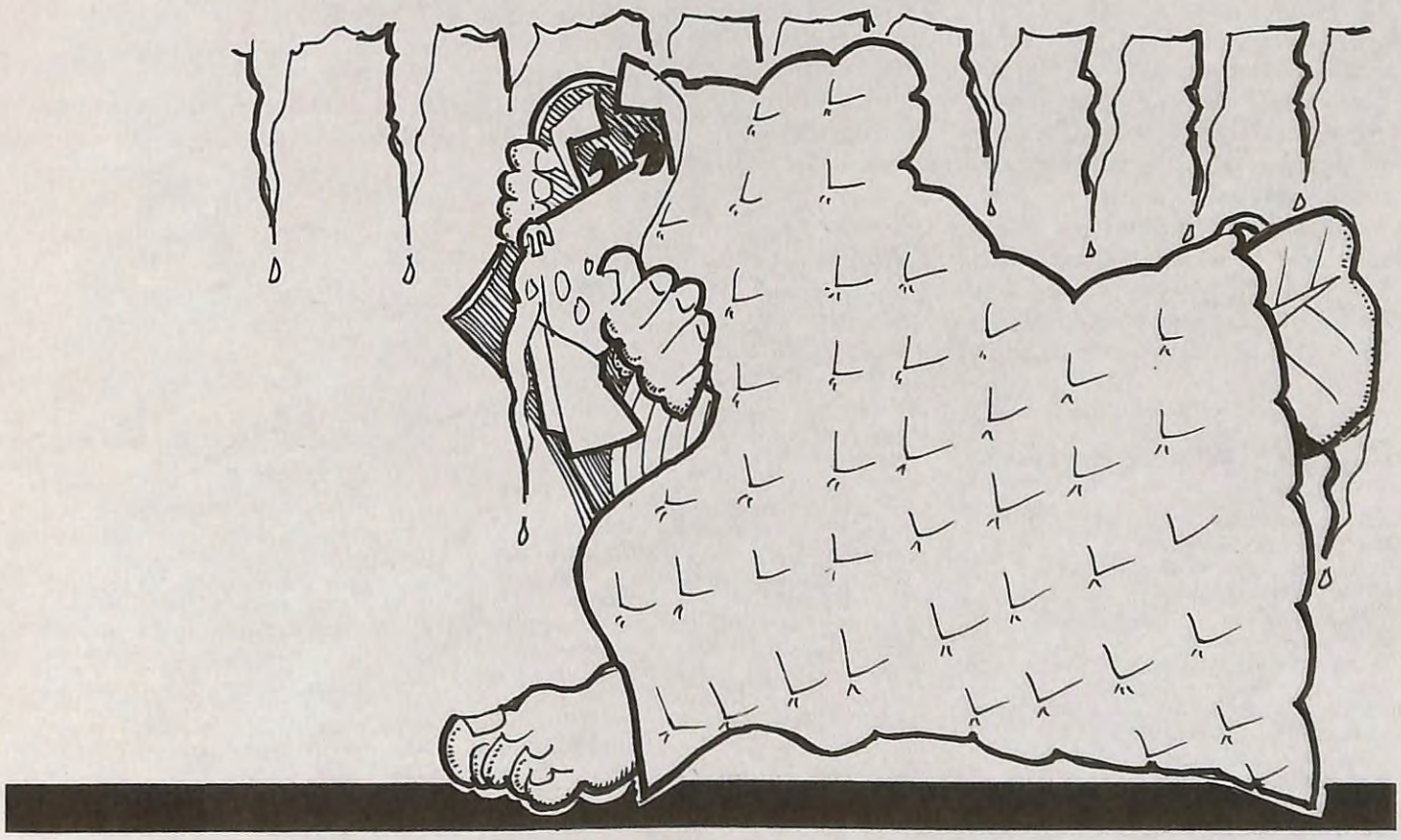
Thermal Bridging



From the Editor . . .

Building regulations are established for the purposes of setting basic standards. They define the least that can be legally built to provide structurally sound and safe buildings.

Over the years the building code has evolved into a complex document, with many prescriptive and performance requirements. Not too long ago the code went through a thorough review and moved to an objective-based code, minimizing prescriptive rules. Every provision was reviewed to make sure that every clause could be justified meeting the basic code objectives.

Regulations for larger buildings typically involve much professional participation and generally have relied on a considerable amount of professional discretion and performance objectives. On the other hand, Part 9 of the code, which is applicable to houses and small buildings, has largely relied on detailed prescriptive requirements, even though the same code objectives apply.

The assumption behind the Part 9 requirements is that a homeowner should be able to build his own home. Thus regulations are written in the context that the building should be able to be built without having to rely on professional inputs, so it tends to be very prescriptive.

Because codes are reactive, and changes are largely done on the basis of suggestions that come in from code users, they can't always easily deal with innovations and changes in technology. so they sometimes seem to be out of touch with industry. However, code objectives are equally applicable to Part 9, so that any innovation, new materials, or changed technology that is not explicitly covered by prescriptive requirements can be used provided they can be seen to comply with the code objectives.

The theoretical benefit of objective-based codes is that they make it easy to innovate. Objective-based codes rely on an understanding of the basic objectives and their intent.

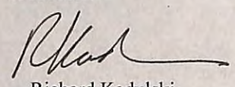
Code-alternative solutions should be easier to achieve. The downside is that they require individuals in the industry and regulators to do honest reviews and apply the intent of the code, while considering scientific principles and risk analysis using the best knowledge of the day.

However, there are situations where authorities having jurisdiction are not comfortable dealing with alternate solutions. As a result they won't accept them, or insist on solutions that so narrowly follow some prescriptive regulations that it almost becomes meaningless.

I've again recently encountered a situation where a building official recognizes the need to address new products and means of construction, but still insists on taking an extremely narrow view of a clause in the code, and refuses to apply scientific evidence and common sense to allow a professional, who's putting his own liability on the line, to follow a slightly different detail.

It's seemingly a case where someone doesn't want to get confused by the facts or be seen to take any risk. It seems they think that if they stick with the old ways of doing things, they can rely on documents that have been in place for years and won't get into legal trouble. And that's no matter that the proposed systems are being implemented daily in many other locations outside their fiefdom. The building official seems to be following a current trend in our national government to avoid doing research because the results might prove embarrassing and not be in accordance with today's ideology.

At the end, it's very frustrating, it doesn't help improve housing stock, and does a disservice to the housing consumer.



Richard Kadulski,
Editor

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Thermal Bridging: Details Do Matter

With an increased concern about energy-efficient building design, more attention needs to be given to details that in the past were glossed over. Although it has been known that some details were problematic, they were ignored because it may have been difficult to quantify their impact on the building's performance. Simplified assumptions were made about heat flows.

Although thermal bridging is a special problem in steel framed buildings because of the high thermal conductivity of metal, it is a concern for all construction types.

Up to now, everyone has tended to use a simplified heat loss analysis procedure, assuming that heat flows in parallel across all building elements. This assumes simple one-dimensional thermal gradients – in other words, that all building components are uniform and extend uniformly in all directions. However, we live in a three-dimensional world, and heat flows – from warm to cold – actually have a three-dimensional profile. Heat loss through the building envelope can be complex. Heat flow varies at corners, parapets and intersections between different assemblies, which makes analysis tricky. The difficulty of detailed heat loss analysis is especially pronounced with high conductivity materials.

Simplified one- and two-dimensional analysis was done in the era of manual calculations, with limited tools and test data results. Today, we have more research data and the availability of sophisticated computer analysis tools, so more accurate calculations can be done.

As we build more energy efficient buildings with higher insulation levels, the small details become big concerns. When heat flows through one element of an assembly at a much higher rate than another it can lead to major problems. Cold spots can mean condensation, affect durability, and of course, lead to increased heat loss across the building envelope.

The total surface area of the thermal bridges may seem small, which is why they have been ignored until recently. However, they do add up and can be significant factors in reducing the effective performance of construction assemblies. Building energy standards, such as ASHRAE 90.1 (a standard that is referenced in many building codes), requires that thermal bridging be recognised, but effectively has allowed a significant portion of thermal bridging to be ignored.

In order to develop better tools for building designers to estimate the thermal performance of the building envelope, ASHRAE undertook a research project to provide thermal performance data for a catalogue of common building envelope details for mid- and high-rise construction. The project goal was to develop procedures and a catalogue to allow designers quick and straightforward access to information with sufficient complexity and accuracy to reduce uncertainty in the thermal performance of building envelope components. The results are based on computer modelling and testing to validate the accuracy of the simulation software.

Morrison Hershfield Ltd. was the principal investigator for ASHRAE Research Project 1365 *Thermal Performance of Building Envelope Details for Mid- and High-Rise Buildings*. The study focused on Part 3 buildings – concrete and steel framing. However, it does have lessons for all building types. And this study is poised to become a game changer for the industry since the procedures and data developed make it relatively simple to account for the impact of details that were previously largely overlooked.

The study found that thermal bridging through the cladding attachments can have a very large effect on the overall heat loss through an assembly, especially with higher levels of insulation, including continuous exterior insulation. This is of special interest today with the code requirements for effective R-values, not nominal.

A common attachment system is the use a Z-girts – metal channels that are fastened to the structure, and fit around the continuous insulation

It doesn't matter how much insulation is added to a wall if most of the heat loss ends up through small details or features that cause significant thermal bridging.

3-D modelling can be used to analyze common building envelope details and to show their thermal performance.

Today it is possible to separate the clear field of the wall from major thermal bridges and categorize the thermal performance of various building envelope details commonly used by designers.

The research study and other technical information is available on the Morrison Hershfield web site – look for 'technical papers'. http://www.morrisonhershfield.com

so the exterior face provides the fastening surface for the cladding material. The vertical z-girt system is commonly used because of its high structural strength. However, it is also thermally inefficient because the Z-girts and steel studs are directly aligned, creating a straight path for heat to flow through the assembly. The thermal bridging can result in more than double the expected heat loss.

In the case of horizontal Z-girts, the heat flow paths are less direct and the amount of steel overlap is greatly reduced when compared to the vertical Z-girt system. This improves the effective R-value, but only modestly because the Z-girts still bypass the entire thickness of the exterior insulation. If both vertical and horizontal Z-girts are used, each Z-girt only partially cuts through the insulation, and the heat flow paths are further reduced to result in a better R-value assembly than the previous two systems.

Although Z-girts are part of non-combustible steel construction, they are occasionally used in wood frame construction. Although wood framing may not have as high a conductivity as metal, it nevertheless has a significant effect on thermal performance. And is not uncommon to see builders install continuous rigid insulation across the exterior of the house, only to lose its benefits when 2x wood strapping is attached to the framing between sheets of insulation for cladding attachment.

One of the important lessons of the study is that in order to achieve high levels of effective thermal resistance in steel stud walls, it is more important to find ways of eliminating, or thermally breaking the metal elements passing through the insulation.

The overall thermal performance of a wall is strongly dependent on the nature of the structural attachment of cladding materials. The use of attachments that provide significant reductions in thermal bridging such as thermally broken vertical Z-girts or combined horizontal and vertical Z-girts, provide improvements in the effective thermal resistances of wall assemblies.

One approach to reduce thermal bridging is to use attachment methods that minimize the cross sectional area of metal that passes through the insulation. This means rather than continuous elements, discreet fasteners should be used. For example, brick veneer systems generally perform better because brick ties are not continuous.

Another approach is to thermally break the structural components passing through the insulation.

A number of systems have been proposed including structurally efficient cladding support systems, non metallic structural elements, and low conductivity thermal breaks.

Often fiberglass batt insulation is added to fill the stud cavity in order to further increase the thermal resistance of an exterior insulated steel stud assembly. In the case of a horizontal Z-girt arrangement, which has the smallest direct contact area, adding R-12 batt in the stud cavity increases the assembly R-value by, on average, R-7.5. These results will differ using other systems, but only slightly. In general, it was noted that insulation in the stud cavity of an exterior insulated steel stud wall assembly will add approximately 60% of the rated nominal insulation value to the thermal resistance of the assembly. This improvement may seem modest for the increased nominal R-value, but it may be important in meeting code. ☼

Thermal Break for Beams & Slabs

The current design fashion for glass towers and projecting balconies or fins means extremely inefficient buildings. Thermal bridges in high-rise construction, especially residential buildings with balconies, make the buildings resemble giant sized radiators.

The total area of the thermal bridges – balcony slabs, floor slab fins, or canopy protections -- may be a small portion of the total building envelope. Although the overall area may be small, the heat loss at the uninsulated floor slab bands and fins means that the overall effectiveness of the building envelope is very low and may not really meet basic energy code requirements if they were to be analysed in detail.

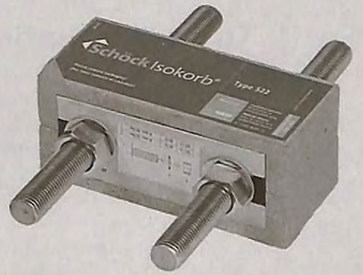
The challenge is to address the thermal bridges.

These thermal bridge conditions are not unique to large high-rise towers. Today, we see more concrete and steel framing in residential construction, especially custom homes. There are many cases where steel structural elements are used to support cantilevers. These steel elements may penetrate from inside to the exterior, so each case represents a major thermal weak point.

The heat flow adds to the heating load of the house. In areas where the thermal bridges occur, the inner surface temperature of the adjacent balcony or steel beam can be lowered to below dew point. This can lead to condensation, deterioration of interior finishes and the formation of mould growth.

Introducing a thermal break to a cantilevered slab or beam may seem difficult to do, but there are systems on the market that make this possible. These are specially engineered components that incorporate a high-density polystyrene foam block and stainless steel components to provide a thermal break.

One system that has recently entered the market in Canada is *Schöck Isokorb®* which is a German-developed load-bearing thermal insulation element. It minimizes thermal bridges in the building envelope between the interior and exterior structures. At the same time, it transfers loads from the exterior structures to the interior structure. The manufacturer has a unit that is designed for concrete slabs, and another for steel beams.



Thermal break unit for steel beam

Schoeck Canada Inc.
www.schoeck.ca

Cascadia Clip
Fiberglass Thermal Spacer

The Cascadia Clip is a cladding support system for exterior insulated walls. Low-conductivity fiberglass material reduces thermal bridging by separating the steel girts from the back-up wall and allows the insulation value to be fully realized. This eliminates the degradation of insulation value that occurs with traditional steel Z-girts and clips and greatly improves the effective thermal performance of the insulation.

The clips are intermittent and are sandwiched between continuous Z-girts to the outside and the sheathing of the back-up wall to the inside. The fasteners (two per clip) attach the Z-girts to the back-up wall studs, passing through holes in the clips. The clips and fasteners are required to resist vertical loads imposed by cladding weight, and horizontal loads imposed by wind pressures and inertial forces from earthquakes. Wind loads are assumed to govern lateral load scenarios.

Although this product was designed for larger scale (Part 3) construction, it can be used on low-rise wood frame construction. It does address concerns some have about structural support of exterior claddings in the presence of continuous exterior insulation.

The clips come in four sizes – from 3½" to 6" to accommodate varying insulation thicknesses.

Information
www.cascadiawindows.com

Fiberglass Spacer Thermal Performance		
2x4 Steel studs @ 16" o/c		Effective R-value
3.5" clip & mineral wool	Stud cavity empty	14.1
	Stud cavity with R-12 batts	18.0
4" clip & 4" mineral wool	Stud cavity empty	15.7
	Stud cavity with R-12 batts	19.5
2x6 wood studs		
3.5" clip & mineral wool	Stud cavity empty	16.9
	Stud cavity with R-12 batts	29.6
4" clip & 4" mineral wool	Stud cavity empty	18.6
	Stud cavity with R-12 batts	31.2

Mineral wool continuous exterior insulation

Earth Tube Ventilation Systems

Earth tubes, also called earth-to-air heat exchangers (EAHX), are long plastic or concrete pipes laid underground and tied to the air intake of buildings. Their purpose is to take advantage of the fairly constant temperature of the ground to provide some pre- conditioning of the ventilation air – pre-heating in the winter or pre-cooling in the summer.

These systems first received attention in the late 1970s and early 80s but have not been widely adopted. The current push towards a wider use of "green" technologies has renewed interest in the earth tube concept. They are promoted as a simple and effective way to reduce the amount of greenhouse gases associated with the operation of buildings.

Earth tubes have been widely used in some parts of Europe, especially Germany, France, and Switzerland, where hundreds if not thousands of systems have been installed. However, despite the number of residential EAHXs in service in Europe, there is little data about their actual performance, both in terms of quantifiable energy savings and their impact on indoor air quality. That is why Canada Mortgage and Housing Corporation (CMHC) undertook a study in 2010 to research the availability of valid information on earth tube ventilation systems and their applicability in the Canadian climate.

The study was mainly a literature search – looking for information on identified systems in Canada and other parts of the world. Actual monitored performance data were sought.

In Canada about 30 residential systems and 10 commercial systems in existence or being built were identified. Information was obtained through contacts with their designers or operators. Although the focus of the study was residential systems in Canada, because of the small number of systems they also looked at examples in the US and Europe.

Monitored results show that, under the right circumstances, earth tubes can provide some benefits both on a seasonal and daily basis. On average, air delivered by the EAHX is warmer than outside air in winter, and cooler in summer. The daily temperature range is reduced, and the EAHX appears effective at clipping temperature peaks during hot days in summer.

Available information suggests that their performance varies with the temperature difference between ambient air and the ground: the capacity and coefficient of performance (COP) appears very high when the difference is large and very low when the temperatures are close to each other. The numbers appear radically different depending on when they are measured or over what period they are averaged. Seasonal COPs are frequently reported in the range 3 to 4.

A typical residential EAHX will have an average cooling power around 1.5 kW with peak cooling power around 4 kW, although this will depend on local climate and soil conditions.

In North America users report mixed results. Some express general satisfaction with the systems, but objective performance indicators are lacking. Others report that their systems do not always work as expected, so it is hard to draw general conclusions.

The possible reason why EAHXs are more common in Europe is that they may offer enough cooling to enable the house to remain comfortable through heat spells, thus reducing the need for mechanical air-conditioning. The situation is not necessarily similar in Canada because EAHXs do not have significant dehumidification potential – a capability important for a number of Canadian locations.

However, experience with existing systems shows numerous potential areas of concern.

Although they appear simple, these are actually quite complex systems. Materials used and construction techniques have to be done carefully to avoid infiltration of water and radon, mould problems and accumulation of condensates. They involve both sensible and latent heat transfer and require sophisticated controls because the systems need to be bypassed during some periods of the year.

Ground temperature will vary depending on how much energy was extracted in the previous hours or days. This will affect how much energy there is for heating or cooling the air.

Air quality concerns

There are conflicting reports about air quality in EAHXs. Some report that air quality does not seem to be a problem as long as the system is properly designed, installed, operated and maintained.

A properly designed system will include smooth inner tube surfaces with sealed joints, possibly with anti-microbial coatings, a sloped design to collect and drain condensate at a low point, and proper filters at the air intake. Air can't be left stagnant in the tubes, and the filters need to be replaced regularly. Under such conditions, some authors report that good quality air is delivered to the dwelling. However, this may be due to the filtration rather than the fact that air is being drawn through an EAHX.

Nevertheless, the potential for condensation on the surface of the tubes in summer, as warm, humid air is drawn through tubes in contact with the cool earth, is a concern as it may lead to the growth of mould and bacteria. Some proponents of the PassivHaus standard have reported evidence of air quality problems with earth tubes in northern Europe, especially in Scandinavia, but not in Central Europe, though they aren't sure why they don't have these problems in Central Europe.

The literature reviewed strongly suggests that operating EAHXs continuously year round is not helpful. Many reports indicate EAHXs deliver warm air when cold air is needed, or vice versa. For example in the middle of summer it may be better to stop the EAHX at night and draw air directly from the outside if it is cooler.

This is also a problem in fall and spring. In spring, ground temperature lags behind the ambient air temperature, so the EAHX tends to cool, not warm, the air it brings into the house. Under such conditions it can add to the heat load of the house. Manual controls (seasonal bypass or manually operable switch), or automated bypasses can avoid stagnant air sitting in the tubes for extended periods of time, but this adds complexities to a system that is initially being used for its simplicity.

Long-Term Ground Temperature Imbalance

The heating or cooling capacity is reduced over time depending on the thermal properties of the ground and the airflow rate in the EAHX.

The heating or cooling capacity measured over a month will be much lower than that measured over one day. This happens both in winter and in summer. An EAHX operating in a cold climate in winter with sub-zero temperatures for weeks may actually freeze the ground around some parts of the EAHX. In the summer, the EAHX may be effective for the first few days of a heat wave but not if the heat wave persists.

Interaction With The Heat Recovery Ventilator (HRV)

From an energy point of view, combining an EAHX and a HRV provides little benefit in heating mode. Both devices are trying to raise the temperature of the incoming air, but the temperature rise caused by the EAHX makes the HRV work less efficiently, so the combined energy gain is much less than the sum of the gains of each system working independently. This has been confirmed by several experimental studies which have shown that when an HRV is present, the energy advantage of combining it with an EAHX is minimal.

One of the often-cited benefits of the EAHX in Europe is to provide frost protection to the HRV. However, in North America HRVs have defrost cycles that achieve the same result at no additional cost since they are standard in all units.

With system costs typically reported in the range of $2,000 to $3,000 or even more, payback is often reported to be as long as 10 to 20 years as long as excavation costs are kept to a minimum. And it is excavation expenses that are a major part of the overall system cost. Other factors that reduce the economic appeal of EAHXs are the fact that the systems tend to work seasonally, that they require sophisticated controls or risk heating and cooling when they should not, and that their functionality overlaps that of the HRV in heating mode.

It should also be noted that EAHX systems can only be used with airtight building envelopes: in leaky houses when infiltration is high, the earth tubes provide additional fresh air that may not be needed.

A poorly designed system will not work as expected, or result in poor air quality, leading in many cases decommissioning. It is very difficult to fix EAHXs once the trenches are back-filled.☼

Earth Tube Ventilation Systems - Applicability in the Canadian Climate
Didier Thevenard, Numerical Logics Inc

CMHC Research Highlight Technical Series 11-103

Earth Tube Ventilation Monitoring Case Study

The consequences of not building a home properly, and not commissioning the systems can be devastating. A technical paper at the ASHRAE winter meeting in January described the problems at a Passive House in Belgium. The house was condemned by health authorities less than 2 years after the family of five moved in.

The 2,000 sq.ft. two-storey house was a slab-on-grade, wood-frame house with brick veneer on the exterior built to Passive House standards. The insulation under the slab-on grade was R-35; the exterior walls had an effective R-value of 43, high performance triple-glazed windows, and a vaulted roof with R-43. The climate is similar to that of Vancouver.

The air and vapour barrier was OSB installed on the interior of the framing, behind the gypsum board interior finish. The 12-inch thick framing cavity had a vapour permeable fibreboard exterior sheathing and was insulated with poorly installed cellulose insulation that settled leaving a 2-inch gap. In addition, the brick veneer was poorly installed with the cavity being unvented. Research has shown that venting of a rain screen – whether it is brick veneer or other siding – is crucial to drying the wall assembly and minimizing moisture problems. This led to solar driven reverse vapour flow of the moisture that the exterior bricks had absorbed. The moisture absorbed by the bricks was driven towards the interior OSB which also became the urea-formaldehyde emitter.

The ventilation system was a balanced heat recovery ventilation system supplied through a ground tube (earth-to-air heat exchanger), with a heating coil on the supply duct on the interior to provide any required heating. The house was airtight at 0.68 Air Changes @ 50 Pascals (slightly more than the Passive House standard limit of 0.60 ACH @ 50 Pa). The home's energy consumption was less than 100 kWh/m^2 per year.

Shortly after moving in, the residents complained about worsening health. Health complaints included coughing, shortness of breath, headache, dry throat, pain and weakness in the legs, painful muscles, fever, diarrhea, nausea, tiredness, and loss of taste. Visitors to the house developed similar symptoms after a couple of days. The complaints were confirmed by a medical diagnosis of parents and children at a university hospital. Once the family left the house after it had been condemned, the health complaints disappeared.

Investigation revealed that indoor air was polluted with high levels of mould spores, dust particles, high VOC levels (especially formaldehyde), and high humidity. Stagnant water was discovered in the ground tube, with a poor ventilation system design so that fresh air ventilation flows were too low; measured air-flows were half that required by Belgian code requirements for ventilation.

The contractor replaced the ground tubes twice without any success – the pipes did not remain dry. In the summer, the relative humidity in the pipe was more than 80% during prolonged periods of time, creating favourable conditions for moulds. High humidities were also measured in the house.

Ground pipes (earth-to-air heat exchangers) are a potentially risky technology. Though promoted as energy savers, their impact on energy consumed is too minimal, but their risk in terms of poor supply air quality is high enough to question their use.

The most energy efficient homes must not only be built energy efficiently but they must be able to function properly, and must be commissioned. If they are, they will provide a healthy indoor environment. This is something that gets overlooked. That is why the R-2000 has always had a protocol for inspections and quality assurance before certification. Measurement of the balanced ventilation airflows is one of the most important elements.☼

Passive Houses: What May Happen When Energy Efficiency Becomes the Only Paradigm? *by H. Hens, PhD. Paper presented at the AHRAE Winter Conference 2012,*

Letters to the Editor

Re: Durable, Energy-Efficient Walls, Solplan Review 162

I am a little confused by the message you are sending about 9.25 of the National Building Code. You say "it is important to keep the vapour diffusion barrier within the wall assembly, on the back side of the exterior insulation and not on the interior of the wall".

Nothing in 9.25.1.1 says we can avoid the installation of the vapour barrier required by 9.25.4. In fact, a simple temperature profile/dewpoint calculation using the ratios in table 9.25.5.2 clearly shows that if you rely on the insulated sheathing as the vapour barrier it is typically well below dew-point based on winter design temperature. Table 9.25.5.2 was created on the assumption that there is a vapour barrier which reduces the moisture content in the wall assembly, and therefore the dewpoint. It also acknowledges that the insulated sheathing further inhibits the removal of moisture through BOTH diffusion and air transfer and therefore must be kept a little warmer than more diffusive and leakier sheathings.

At least that is how I read it.

I am not 100% sure the sentence I quoted was trying to say the ratio in Table 9.25.5.2 is sufficient to satisfy "sufficiently close to the warm side" as required by 9.25.4.3 but if it is, I think you have the wrong interpretation of 9.25.5.2

John Harris
Toronto, ON

The location of the vapour barrier, and which materials are used for the vapour barrier has been a source of much discussion, debate and at times, confusion. I hope I haven't added to the confusion.

It is important to stress that a vapour diffusion retarder is necessary in all assemblies. Much of the discussion is about the nature of that retarder, and its location.

We need to look at first principles. A wall assembly must be airtight, to prevent air leakage through it, whether it is infiltration into the wall from the outside or exfiltration out of the house. This is because it is air movement that is the major driver of moisture that can lead to moisture problems. If we have an airtight assembly, we will not be dealing with air leakage, so the major concern becomes vapour diffusion.

Water movement by diffusion is a small driver, but still can be significant in some conditions and in some locations that might experience high humidity levels. For vapour drive to occur there needs to be a vapour pressure differential across the assembly.

Since vapour diffusion is the movement of water molecules suspended in the air through the pores of a material, low vapour permeance materials that are classed as vapour barriers are used to retard the movement of those water molecules.

The code requirements do not restrict the placement of the vapour barrier on the interior – the low permeance plane merely has to be placed at a location where it will remain above the dew point at design conditions.

If the plane of low permeance – the vapour diffusion retarder (i.e. the 'vapour barrier') – is at a point within the assembly that is above the dew point, then vapour driven moisture will not condense. In most of southern Canada (less than 6,000 Degree Days °C) 2" thick low-permeance insulated sheathing on a 2x6 stud wall will have an interior temperature that is above the dew point so it can function as the principal vapour barrier – even when there is some insulation placed within the stud wall.

It is also important to remember that most analysis is done at a steady state condition, which is a simplification of real world conditions. It does not take into account the dynamic variations over the day and season, and the fact that most materials have a storage capacity to absorb some moisture. The moisture movement that leads to the assembly absorbing some moisture is reversible, so that drying can also take place when conditions change.

Placing an extremely low permeance vapour barrier (e.g. polyethylene) on the interior side of the wall, and then using a low permeance insulating sheathing on the exterior sets up the condition where you could have two vapour barriers that can trap construction moisture, and has little forgiveness for any incidental moisture migration through the assembly.

Placing continuous insulation on the exterior, over the structure, provides higher, more effective insulation values and also keeps the structure warm and less subject to climatic stresses. *Ed.*

Ottawa Home: First Home Certified to the 2012 R-2000 Standard

R-2000 certified homes are some of the most energy efficient houses on the market. As a *best-in-class* energy efficiency label for 30 years, the R-2000 Standard has always challenged builders with developing creative new ways to meet its strict technical requirements, keeping innovation as one of the main principles of R-2000.

Over the last two years, Natural Resources Canada (NRCan) has worked in conjunction with a multi-stakeholder committee to update the technical standards for the R-2000 initiative and keep it at the forefront of housing energy efficiency. The 2012 R-2000 Standard, currently phase one of a two-phase process that will see further changes in 2014, calls for energy efficiency requirements that have been increased by 50% compared with the 2005 standard.

The R-2000 Standard is a voluntary technical performance standard for new homes that are energy efficient and environmentally responsible. This includes superior indoor air quality, homeowner comfort, and low energy demand. All R-2000 homes are constructed by licensed and trained builders, evaluated, inspected and tested by independent third-party energy advisors, and are certified by the Government of Canada.

With the publication of the updated standard in February 2012, NRCan has challenged builders to reach the next level of leading-edge, energy-efficient new home construction. R-2000 builders are innovative, industry leaders knowledgeable in the latest building techniques, energy-efficient features and environmentally friendly materials in new home construction. One of these builders up for the challenge was Ontario's Urbandale Construction.

Urbandale built the first R-2000 home certified to the new 2012 R-2000 Standard in Canada. It was unveiled at the launch of the 2012 R-2000 Standard, February 16, 2012.

Builders have options in how to meet the strict technical requirements of the standard. Urbandale's home design does not seem to be unlike the one next door, but it really is exceptionally different. "We wanted to build a high performance house that felt like a home, not a science project," Matthew Sachs, General Manager of Urbandale Construction, said at the launch.

The house is wrapped in a layer of continuous insulation, including under-slab insulation. The concrete foundation walls have additional insulation and waterproofing on the exterior all the way from the footings to the sill plate, with spray foam in the rim joist to ensure a continuous air barrier. On top of the regular two-by-six construction with its cavity insulation, an exterior structurally insulated sheathing was installed, enhancing both the structural and insulating properties of the wall.

The windows are not the typical type for Ottawa. The house is located in an ENERGY STAR Zone B climate zone but Zone D arctic climate zone triple-pane windows were installed throughout.

Special attention was paid to select energy efficient mechanical systems. A ground-source heat pump gives the home very efficient heating in the winter and cooling in the summer. In addition to a heat recovery ventilator, which is typically found in R-2000 homes, this house features an instantaneous tankless water heater and a drain water heat recovery system.

Each R-2000 home also incorporates environmentally friendly features, as chosen by builders from a pick list — this home included low-emission cabinetry and paint to improve indoor air quality, water-conserving faucets, and energy-saving compact fluorescent lighting.

Urbandale was also innovative during the design phase, as Carleton University and their mechanical engineering students were involved in designing the home using advanced computer modelling to explore innovative design concepts that were eventually incorporated in the home. According to Sachs, Urbandale believes it is "critical for the housing industry to support research and development to move the housing technology forward". By partnering with academia during the design stage of the home, Urbandale has proven just that.

R-2000 homes have helped thousands of Canadians make the best choices for energy efficiency in their homes. NRCan eagerly awaits how other builders will take on the challenge to meet the new 2012 R-2000 Standard.☼

Technical Research Committee News

Canadian Home Builders' Association

York International Corp. Recall of Gas Furnaces

The US Consumer Product Safety Commission and the manufacturer have announced a voluntary recall of gas furnaces manufactured by Unitary Products Group (UPG) of York International Corp. in Wichita, Kansas.

The furnaces can overheat, causing heat-exchanger cracking, burn-through and, in extreme cases, furnace wrapper burn-through. This can lead to heating and possible burning of the drywall and other combustibles adjacent to the furnace, posing a fire and smoke hazard. UPG has received 27 reports of fires, some resulting in extensive property damage related to these hazards.

The recall involves about 226,000 gas furnaces sold between 1995 and 2000 under the following brands: Coleman, Coleman Evcon and Red T brand furnaces. The furnaces are a silver color with white access panels. The "Coleman," "Coleman Evcon" and "Red T" brand names are located on the middle of the front access panel.

The following model numbers are included in the recall:

DGAM075BDD	DGAM075BDE
DGAM075BDF	DGAT070BDD
DGAT070BDE	DGAT070BDF
DGAT075BDD	DGAT075BDE
DGAT075BDF	DLAS075BDD
DLAS075BDE	DLAS075BDF

Consumers should not use the heating function of these furnaces until it has been inspected and repaired. Contact UPG to schedule a free inspection and repair of any furnace involved in the recall. Information: UPG toll-free at (888) 665-4640 between 8 a.m. and 5 p.m. CT Monday through Friday or *www.dgatprogram.com.*

CSA Safety notice

CSA International has issued an alert regarding Fire on Ice brand gas fireplace installation kits. These are marketed as a decorative and heating appliance that can be inserted in a standard wood-burning fireplace, fire pit or fire table. They consist of a burner unit and parts intended to be covered by coloured, tempered glass. The gas appliance and related documentation bears counterfeit (unauthorized) registered CSA trade-marks on the unit and packaging.

The products were manufactured and distributed by Fire on Ice, Inc., California and sold throughout Canada and the United States. The gas fireplace kits have not been tested or evaluated by CSA International, are not certified by

The Technical Research Committee (TRC) is the industry's forum for the exchange of information on research and development in the housing sector.
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CSA, and are not eligible to bear the CSA International certification mark.

The safety or performance characteristics for these products are unknown to CSA and consumers are advised to contact their point of purchase or local gas regulatory authority for guidance.

Product: Fire On Ice gas fireplace kit with counterfeit CSA certification markings

Buyer's Guide for Residential Ground Source Heat Pump Systems

Ground source heat pump systems offer an efficient option for space and water heating and cooling. They have gained a lot of interest in recent years. The support of NRCan, utilities and provincial agencies for energy efficiency upgrades, have included geothermal systems as a heating option. However, there have been a lot of problems with early geothermal system installations.

To support the industry to upgrade their standards and performance NRCan pushed the industry to create a formal body that could foster the development and improvement of the ground source industry. This led to the incorporation of the Canadian GeoExchage Coalition (CGC). Although the CGC has a mandate to help develop the market, it also has a mission to promote the proper deployment of the ground source systems in Canada.

They have also created a certification program.

The CGC has published the *Buyer's Guide for Residential Ground Source Heat Pump Systems* which is an excellent overview of ground source heat pumps.

It includes information on different geoexchange technologies, system design overview, glossary of terms, guidance on selecting a contractor and what needs to be covered in a basic contract. It also proposes a financial decision-making tool and covers service and maintenance issues as well as basic troubleshooting.

This is a resource that not only consumers but also builders and designers will find useful. A copy can be downloaded from the CGC web site.

http://www.geo-exchange.ca

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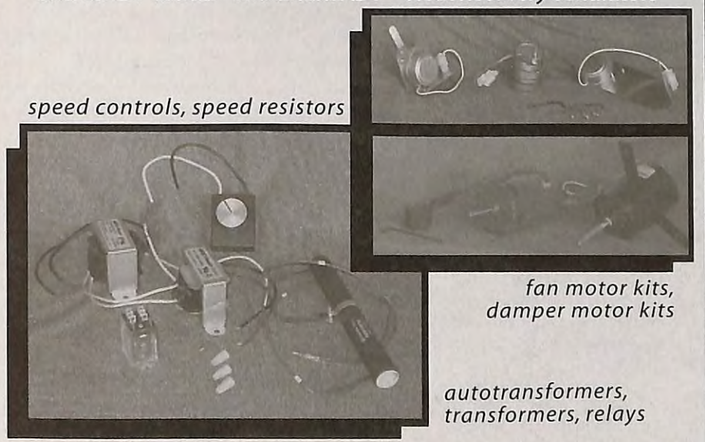
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NRC·CNRC

Summary of NRC Construction Housing Activities for 2011

By John Burrows

NRC Construction engages in a wide range of research and technical activities, including code support, for the benefit of the housing sector. The research program is founded on long-standing expertise in building science and excellent laboratory facilities, which include a number of experimental houses and other full-scale set-ups that permit realistic experimentation and generate reliable results.

This article highlights progress in research achieved by NRC Construction for 2011, based on a report prepared for the 2012 annual conference of the Canadian Home Builders' Association.

Building Envelope and Structure

One of the full-scale houses used by NRC Construction is a two-storey structure that enables large wall sections to be installed and exposed to outdoor conditions. Currently installed on the west-facing wall is a section containing vacuum insulated panels (VIPs), being studied as part of a retrofit of a conventional wall. The goal is to generate performance data in order to develop guidelines for the implementation of next-generation building envelope systems that are superior in energy efficiency. In a separate project, researchers have installed VIPs in an institutional building retrofit in the Yukon to determine their performance in an extreme climate. In this case, the VIPs are sandwiched between two layers of rigid insulation boards to prevent physical or mechanical damage to the panels, an issue of practical concern with regard to the use of this innovative technology. Meanwhile, researchers are continuing their efforts to determine the long-term performance of VIPs.

Another promising technology is cross-laminated timber (CLT), a wood-based material becoming popular in Europe for various types of construction, including certain buildings traditionally built using concrete. NRC Construction researchers have been conducting studies to determine the moisture management performance of the technology. The researchers are working to identify suitable test methods, essential for evaluating any new technology, and to generate hygrothermal performance data for CLTs. The goal is to provide information that will facilitate the design of durable and effective wood-frame construction using this material.

Work is progressing on a long-term project to assess installation details for the wall/window interface in order to manage and control rainwater entry and condensation risks. The research, while laboratory based, takes advantage of unique facilities that enable the testing of full-scale wall sections in which a window is installed. Recently, researchers have been disseminating guidelines for reducing the risk of condensation for window installations incorporating a sill pan. Guidelines are available in Construction Technology Update (No. 76), "Window Sill Details for Effective Drainage of Water."

NRC Construction researchers are also actively studying innovations in roofing technology. One project entails investigating the performance of a roof-integrated photovoltaic (PV) system installed at the Canadian Centre for Housing Technology. This study of a product in actual use, along with laboratory tests and computer modeling, will enable the researchers to determine not only the energy production potential of roof-integrated PVs but also their performance as roofing systems (i.e., against wind loads and weathering effects). The results of this three-pronged approach will be used to develop a computer model to examine heat and moisture performance of these new roofing systems under a variety of climate conditions, and another model to predict whole house energy performance at selected locations across Canada. Design guidelines and installation standards for common PV modules will also be developed, taking all the key issues into account.

In concrete technology, numerous projects are in progress, with the objective of improving performance, extending service life, reducing the carbon footprint, and contributing to sustainability goals. In one study researchers are assessing enhancements for self-compacting, self-levelling concrete products for topping, repair and structural applications. The use of supplementary cementing materials, such as material by-products, is a key area of study. An important aspect of the research is to understand the interaction and synergy between these by-products and other components in the mix, and their effects on the properties of the concrete.

John Burrows is an Ottawa-based consultant and technical writer.

Indoor Environment

The construction industry and consumers have gradually adopted energy-efficient technologies and building practices and the National Research Council has made major contributions through its research. An ongoing NRC Construction project is exploring ways to dramatically reduce household electricity use during periods when utility-wide electricity use is at its highest. The work includes strategies such as creating more-efficient house designs, shifting demand to off-peak times with advanced controls, changing occupant behavior, and encouraging local power generation and storage. Included in the project are simulation and full-scale evaluations at the Canadian Centre for Housing Technology and a review of recent North American utility pilot projects on the effect of time-varying pricing.

Researchers have followed up their several years of study on skylights with a related project investigating ways to measure the lighting and thermal performance of tubular daylighting devices (TDDs). The objective is to provide calculation methods and design tools enabling manufacturers to predict the energy performance of their TDDs, and determine compliance with energy codes.

With the increasing emphasis on indoor air quality in houses and buildings, NRC Construction is pursuing a number of key studies revolving around this issue. In one case, they are working to help Canadian manufacturers to develop building materials that do not promote mould infestation. A method has been developed to accurately predict mould growth-inhibiting properties; it is particularly useful for characterizing advanced building materials and the efficiency of approaches for mould-proofing.

Another project involves a study of twelve types of portable air cleaners, which were evaluated against a newly developed protocol. The evaluation assessed how well the cleaners removed airborne coarse, fine and nano-particles as well as selected volatile organic compounds (VOCs). Also studied was their possible emission of potentially harmful by-products, along with a determination of their energy consumption and acoustical properties. A protocol was also developed to assess the efficiency of air

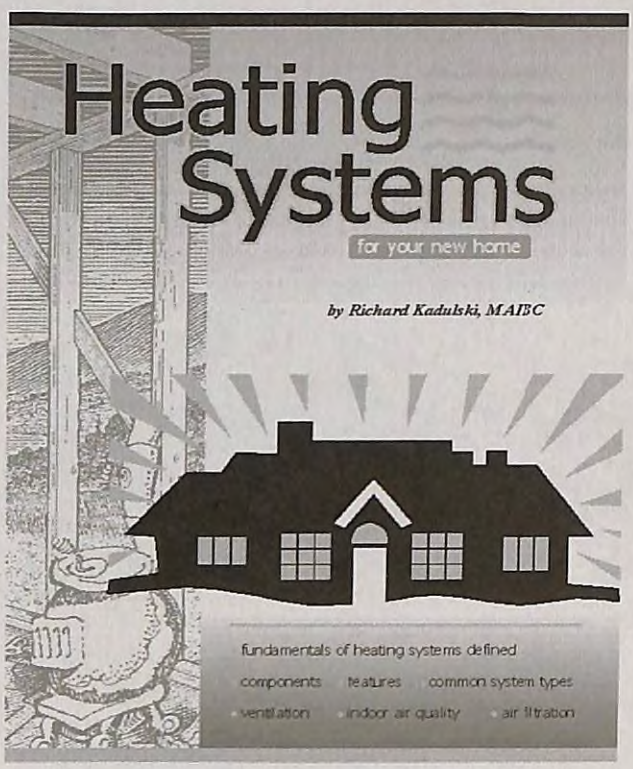
duct cleaning in terms of cleanliness of the ductwork surfaces and the improvement in indoor air quality. Finally, an evaluation protocol was developed to help manufacturers improve product performance.

A collaborative study between NRC Construction and the Institut National de Santé Publique du Québec (INSPQ) was carried out to determine whether enhanced ventilation would produce acceptable indoor air quality (IAQ) for alleviating the respiratory symptoms of asthmatic children. For the study, heat or energy recovery ventilators were introduced to, or optimized in, under-ventilated homes. More information is available on the NRC Construction website.

Fire Research

NRC Construction is continuing to assist industry to develop and apply technologies and practices to enhance the fire safety of housing. A project to determine the characteristics of fires and typical combustible furnishings in multi-suite residential buildings is nearing completion. The results will enable a comprehensive analysis of fire characteristics within such dwellings and a better understanding of these fires.

The complete Housing Activities Report is available at:
http://www.chba.ca/uploads/TRC/March%202012/NRC-IRC%20Housing%20Activities%20Report%20for%202011.pdf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